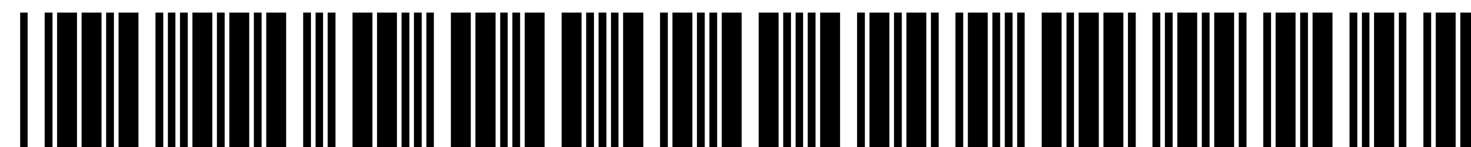

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Harris

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(54) **METHOD AND APPARATUS FOR SECURING MICROELECTRONIC WORKPIECE CONTAINERS**

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(21) Appl. No.: **10/622,018**

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(65) **Prior Publication Data**

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(51) **Int. Cl.**[7] **H01J 40/14**
(52) **U.S. Cl.** **250/221**; 250/559.33
(58) **Field of Search** 250/221, 559.3, 250/559.33; 414/744.5, 744.2, 744.4, 919

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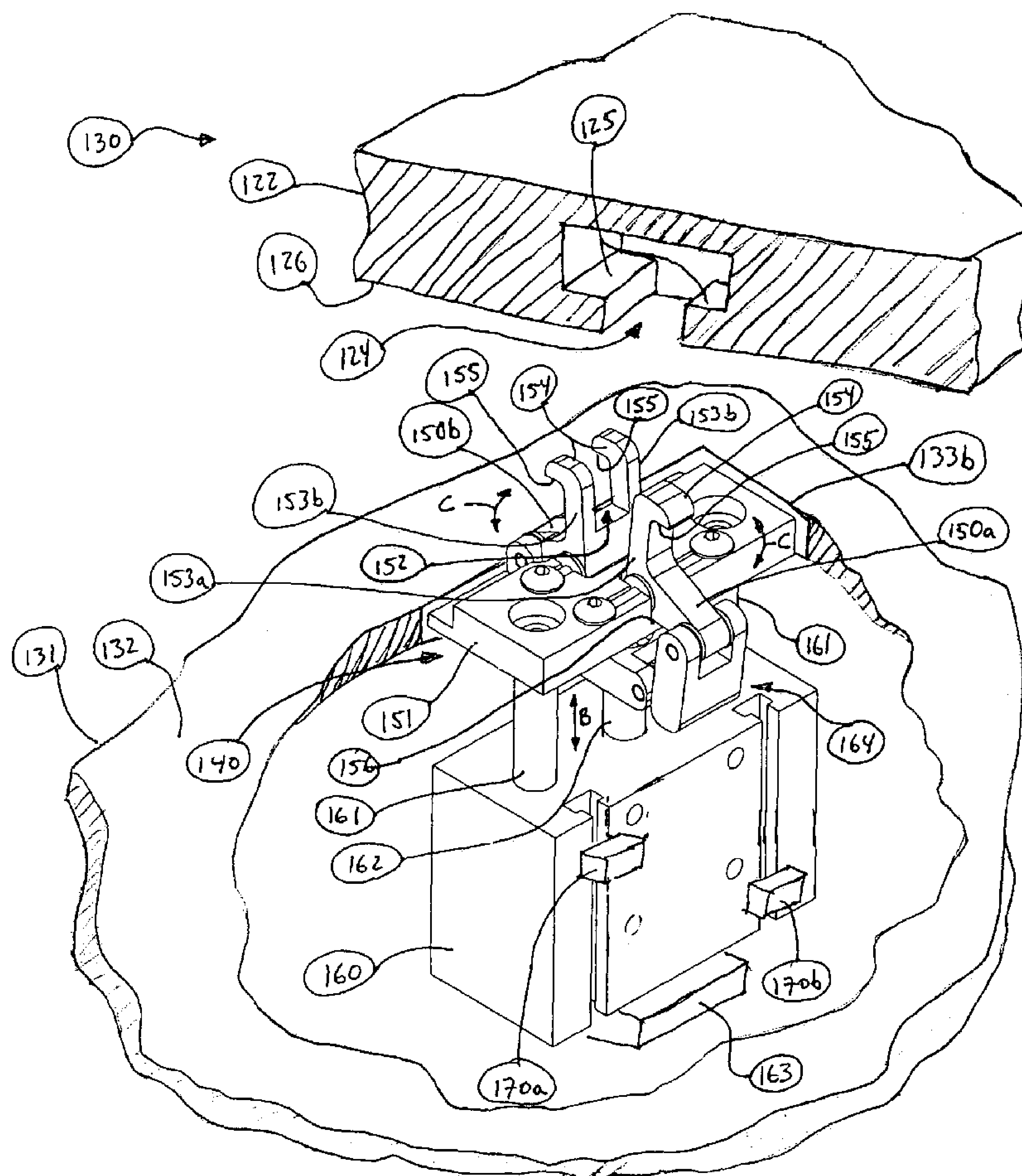
(57) **ABSTRACT**

An apparatus and method for handling microelectronic workpiece containers. In one embodiment, the apparatus includes a container support having one or more support elements positioned to carry a microelectronic workpiece container. A container securement device is positioned at least proximate to the support element(s). A contact surface of the securement device is moved in a first direction so that it contacts or is positioned to contact a surface of the workpiece container. The contact surface is then moved in a second direction different that the first direction to clamp the workpiece container against the support element(s).

29 Claims, 6 Drawing Sheets



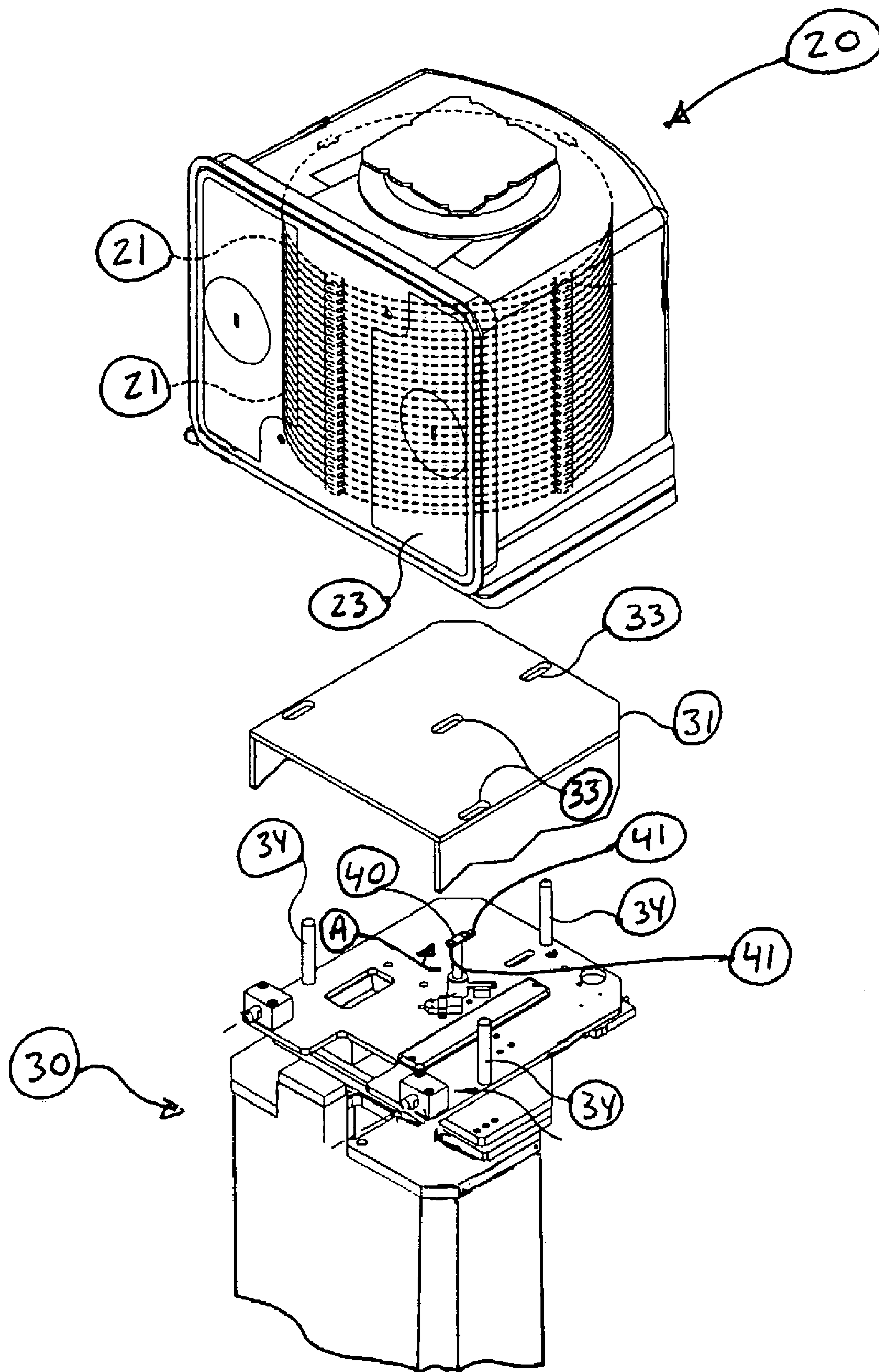


Fig. 1

(Prior Art)

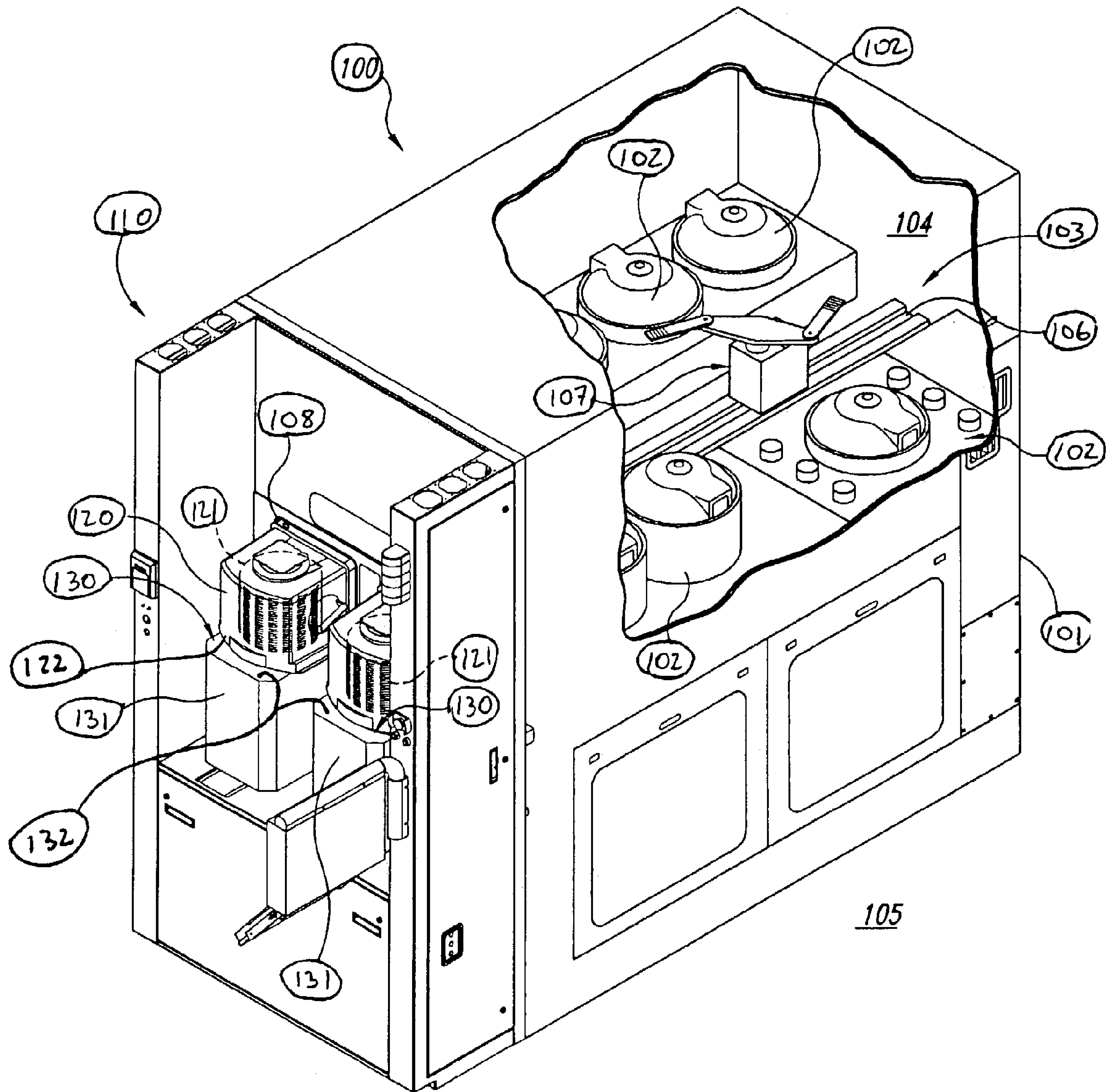


Fig. 2

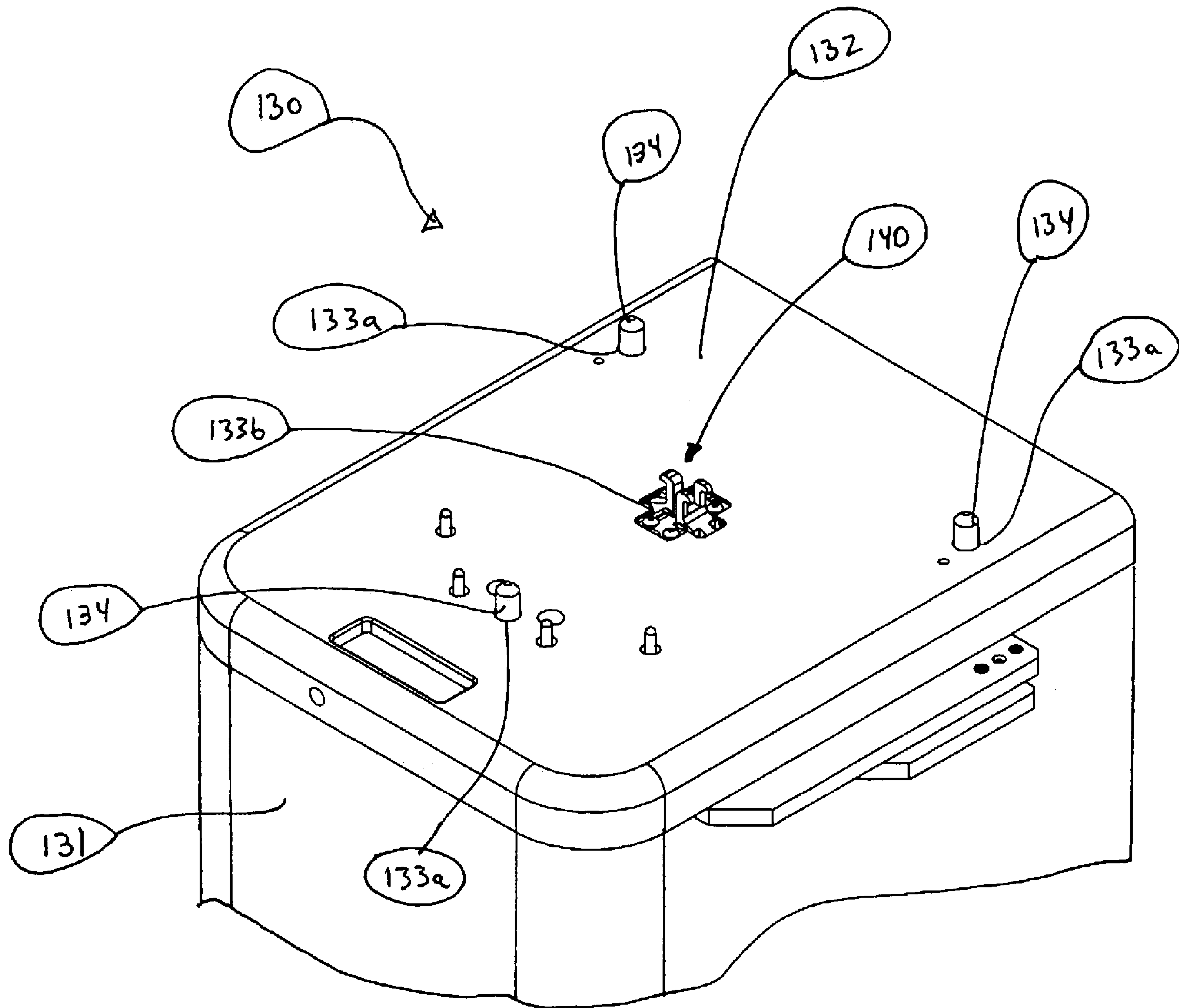
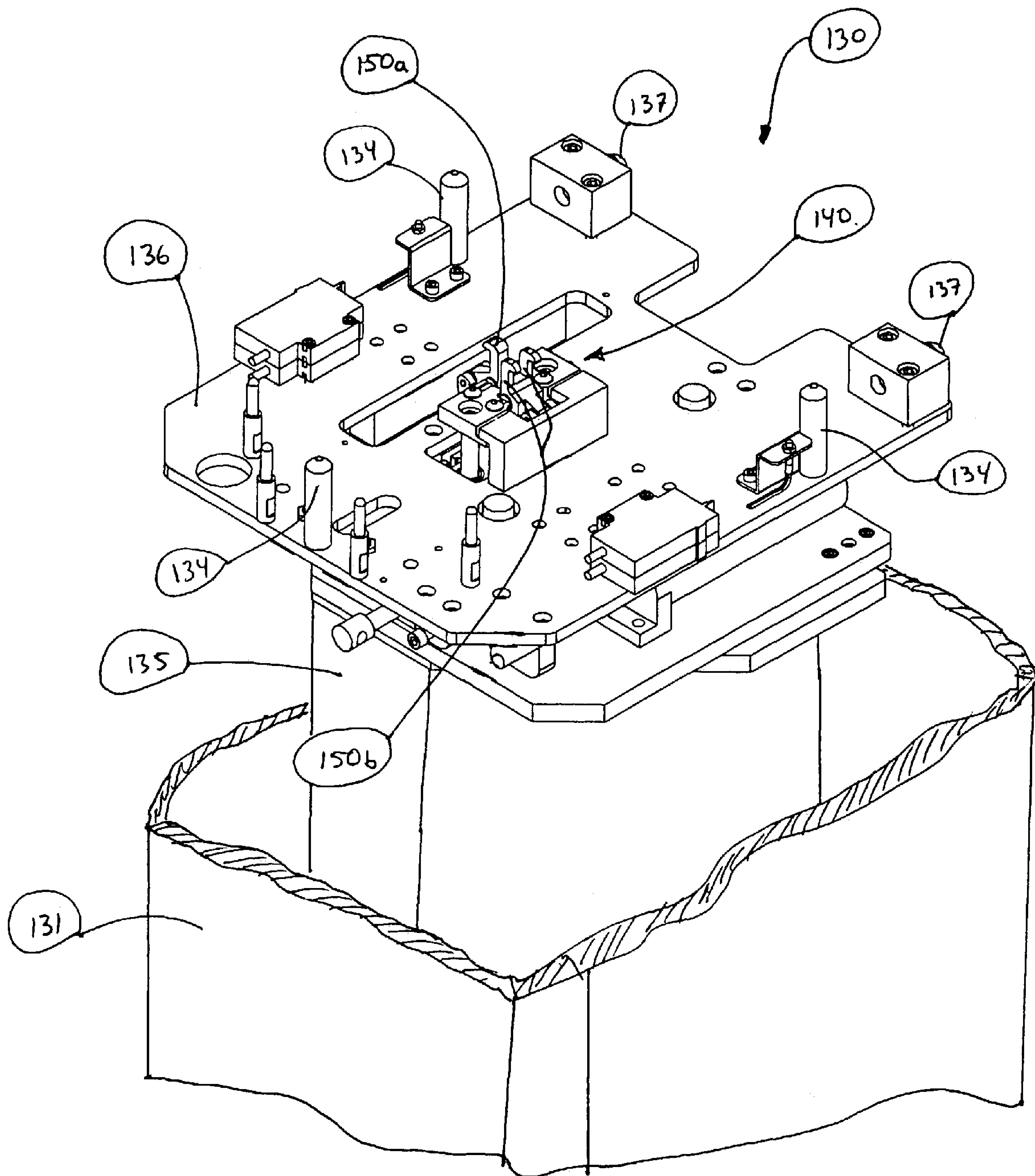


FIG. 3

Fig. 4



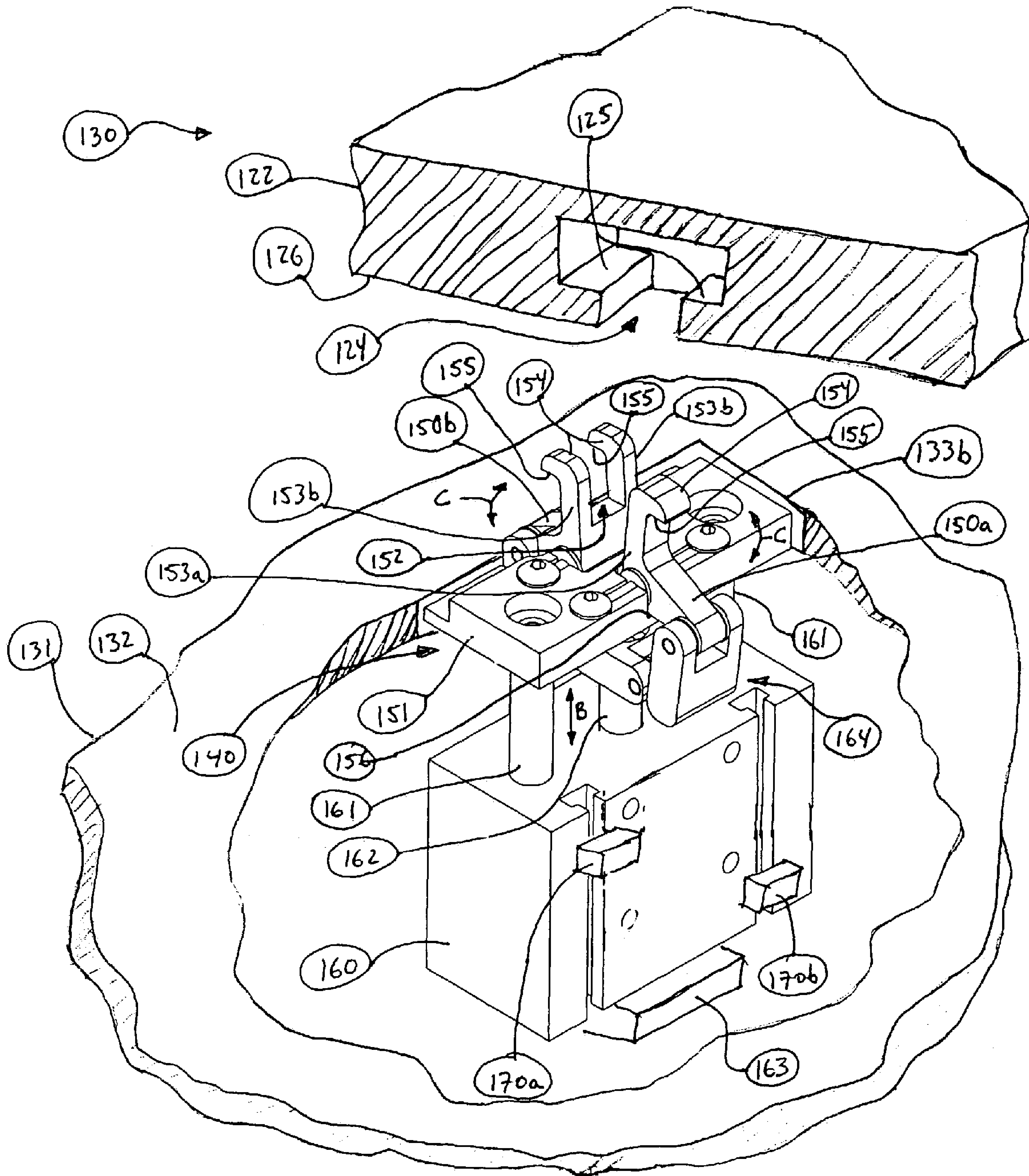


Fig. 5

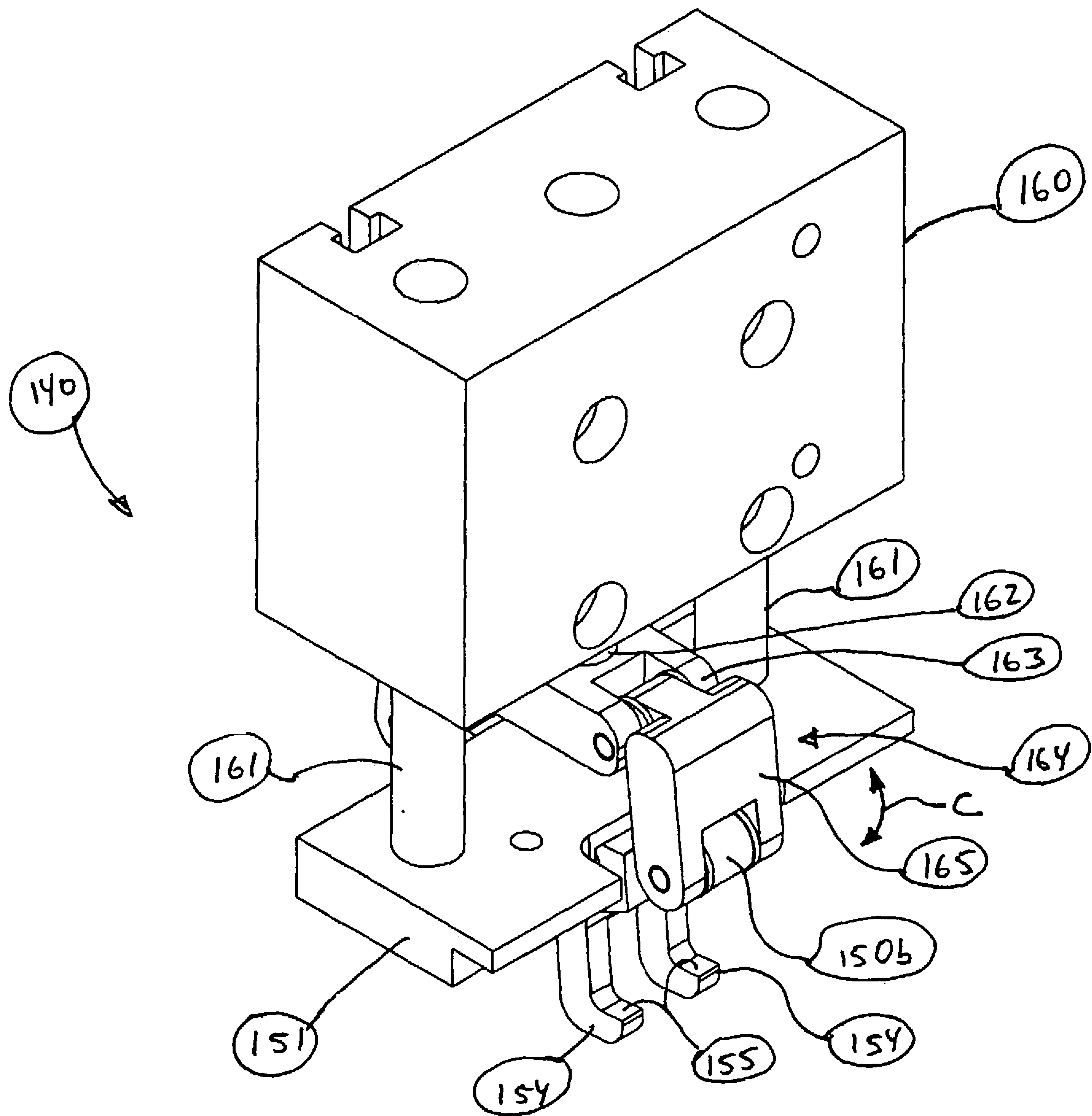


FIG. 6

METHOD AND APPARATUS FOR SECURING MICROELECTRONIC WORKPIECE CONTAINERS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims benefit of U.S. Provisional Patent Application No. 60/396,894, filed Jul. 16, 2002 incorporated herein in its entirety by reference.

TECHNICAL FIELD

The present invention is directed generally to methods and apparatuses for securing microelectronic workpiece containers, for example, methods and apparatuses for securing FOUP containers while the containers are accessed.

BACKGROUND

Microelectronic devices, such as semiconductor devices and field emission displays, are typically fabricated on and/or in microelectronic workpieces using several different types of process machines or tools. A workpiece, for example, is often processed using tools for depositing, implanting, diffusing, doping, etching, polishing/planarizing, and patterning materials. A workpiece typically undergoes several processing steps within a single enclosed clean or "mini" environment within a processing tool. For example, microelectronic workpieces are typically plated with a conductive material, etched, annealed and cleaned, using a plurality of processing stations all housed within a single processing enclosure that defines a clean mini environment.

The foregoing processes can be performed on each workpiece individually in separate single-wafer processing stations, and the workpieces can be moved from one processing station to the next, a technique referred to in the industry as single-wafer processing. One initial problem encountered with single-wafer processing was determining how to deliver individual workpieces to and from the enclosure while maintaining a clean environment within the enclosure. One approach to addressing this problem has been to load several workpieces in a portable container while the container is in a clean environment, and then seal the container with a removable door. Accordingly, the interior of the container can define another clean mini environment. The door is then removed when the container is flush with a hatch of the processing enclosure to reduce the likelihood for introducing contaminants into the enclosure.

FIG. **1** illustrates a conventional container **20** having a Front Opening Unified Pod (FOUP) design in accordance with the prior art. The container **20** supports a plurality of microelectronic workpieces **21** and has a door **23** that is removed for access to the interior of the container **20**. The container **20** is supported relative to a processing tool (not shown) on a container support **30**. The container support **30** has a shroud **31** with openings **33** through which support pins **34** and a latch pin **40** project to engage and secure the container **20** to the container support **30**.

In one aspect of the arrangement shown in FIG. **1**, the latch pin **40** includes outwardly extending arms **41**, each of which has a downwardly facing, circumferentially extending declined plane. The arms **41** project through a corresponding aperture in the bottom of the container **20** when the container **20** is placed on the shroud **31**. As the latch pin **40** rotates in the direction indicated by arrow A, the downwardly facing declined planes begin to engage an upwardly facing surface in the aperture at the base of the container **20**. Because the downwardly facing surfaces of the arms **41** are in declined, the latch pin **40** draws the container **20** downwardly toward the support pins **34** as the latch pin **40** rotates, to secure the container **20** to the container support **30**.

One drawback with the foregoing design described above with reference to FIG. **1** is that the manufacturing tolerances for the container **20**, and in particular, the portion of the container **20** engaged by the latch pin **40**, must be very tight for the latch pin **40** to properly secure the container. For example, if the base of the container is slightly warped, the latch pin **40** may be unable to properly engage the aperture in the base, or may only loosely contact the upwardly facing surface within the aperture. If the container **20** is not properly secured on the container support **30**, it can be jarred or otherwise misaligned, which can cause damage to the microelectronic workpieces **21** when automatic devices attempt to load or unload the container **20**.

SUMMARY

The present invention is directed toward methods and apparatuses for securing microelectronic workpiece containers. One aspect of several embodiments of the invention includes securing a workpiece container to a container support with a device that executes motion in two different directions, one to align a portion of the device in contact with or poised to contact the container, and another to draw the container against the container support. Accordingly, the securement device can positively engage containers that may be warped or have other irregularities because the motion to align the device need not use up the limited travel range available for also securing the container to the support.

For example, in a particular aspect of the invention, the apparatus includes a container support having one or more support elements positioned to carry a microelectronic workpiece container. A container securement device is positioned at least proximate to the support element(s) and has at least one contact surface. The at least one contact surface is movable relative to the support element(s) in a first direction between a first position and a second position, with the contact surface contacting or positioned to contact a surface of the container when in the second position. The contact surface is also movable in a second direction from the second position to a third position with the contact surface clamping the container against the support element(s). The second direction is different than the first direction, which as described above, can allow the device to more readily secure workpiece containers that may be warped or otherwise misshapen.

In further particular aspects of the invention, the at least one contact surface is one of at least two contact surfaces. The contact surfaces are pivotable between the first position and the second position and are movable along a generally linear axis from the second position to the third position. In still a further particular aspect of the invention, the securement device is configured to move the at least one contact surface in the first direction without moving the at least one contact surface in the second direction.

A method in accordance with another aspect of the invention includes contacting a microelectronic workpiece container with at least one support element of a container support. The method further includes moving a contact surface of a securement device in a first direction from a first position to a second position with the contact surface contacting or positioned to contact a surface of the container

when in the second position. The container is then drawn toward the at least one support element with a second motion of the contact surface in a second direction different than the first direction. In further particular aspects of the invention, the contact surface is pivoted in the first direction and is moved along a generally linear path in the second direction.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a partially exploded, top isometric view of a microelectronic workpiece container and container support having characteristics in accordance with the prior art.

FIG. **2** is an isometric view of a processing machine or tool having a container support in accordance with an embodiment of the invention.

FIG. **3** is a top isometric view of a portion of a container support in accordance with an embodiment of the invention.

FIG. **4** is a top isometric view of an internal portion of an embodiment of the container support shown in FIG. **3**.

FIG. **5** is an enlarged, partially broken, isometric view of a portion of an embodiment of the container support shown in FIG. **3**.

FIG. **6** is an inverted view of a portion of the container support shown in FIG. **5**.

DETAILED DESCRIPTION

The following description discloses the details and features of several embodiments of methods and apparatuses for handling microelectronic workpiece containers. The term "microelectronic workpiece" is used throughout to include a workpiece formed from a substrate upon which, and/or in which, features, such as submicron features, including microelectronic circuits or components, data storage elements or layers, and/or micro-mechanical elements are fabricated. It will be appreciated that several of the details set forth below are provided to describe the following embodiments in a manner sufficient to enable a person skilled in the relevant art to make and use the disclosed embodiments. Several of the details and advantages described below may not be necessary to practice certain embodiments of the invention. Additionally, the invention can include other embodiments that are within the scope of the invention but are not described in detail with respect to the FIGS. **2**–**6**.

FIG. **2** is an isometric view of a processing machine or tool **100** having an input/output station **110** that includes container supports **130** in accordance with an embodiment of the invention. A portion of the processing tool **100** is shown in cut-away view to illustrate selected internal components including a plurality of processing stations **102**. In one aspect of this embodiment, the processing tool **100** includes a cabinet **101** defining an enclosure that at least partially isolates an interior region **104** from an exterior region **105**. The cabinet **101** also includes a plurality of apertures **108** (one of which is visible in FIG. **2**) through which microelectronic workpieces move as they are transferred between the interior region **104** and the input/output station **110**.

In one embodiment, the input/output station **110** includes two container supports **130**, each housed in a protective shroud **131**. In other embodiments, the input/output station **110** includes more or fewer container supports **130**. In any of these embodiments, the container supports **130** are configured to position workpiece containers **120** relative to the apertures **108** in the cabinet **101**. Accordingly, each shroud **131** includes an upper surface **132** proximate to a floor **122** of the workpiece container **120**. Each workpiece container **120** houses a plurality of microelectronic workpieces **121** in a "mini" clean environment suitable for carrying a plurality of workpieces through other environments that are not at clean room standards. In one aspect of this embodiment, the workpiece container **120** includes a FOUP (Front Opening Unified Pod) device. Accordingly, the container **120** conforms with standards set forth by SEMATECH, or other semiconductor industry standards. In other embodiments, the container **120** is a non-standard device. In any of these embodiments, each of the workpiece containers **120** is accessible from the interior region **104** of the tool **100** through the apertures **108**.

The interior region **104** of the tool **100** includes a plurality of the processing stations **102**, such as electroless and/or electrolytic material deposition stations, clean/etch stations, annealing stations, metrology stations, and/or other processing stations. A transfer device **103** moves the microelectronic workpieces **121** between the input/output station **110** and the processing stations **102**. In one embodiment, the transfer device **103** includes a linear track **106** extending in a lengthwise direction in the interior region **104** between the processing stations **102**. The transfer device **103** includes a robot unit **107** carried by the track **106**. In a particular embodiment shown in FIG. **2**, the linear track **106** extends between first and second rows of processing stations **102**, and the robot unit **107** moves the microelectronic workpieces **121** from the input/output station **110** to one or more of the processing stations **102** and back to the input/output station **110**.

FIG. **3** is a top isometric view of a portion of one of the container supports **130** positioned at the input/output station **110** described above with reference to FIG. **2**. In one aspect of this embodiment, the upper surface **132** includes a plurality of shroud apertures **133** (shown as first shroud apertures **133*a*** and a second shroud aperture **133*b***) positioned to allow components within the shroud **131** to access the workpiece container **120**. For example, in one embodiment, one or more support elements **134** (for example, pins) project upwardly through the first shroud apertures **133*a*** to seat and align the workpiece container **120**. In other embodiments, other surfaces seat the workpiece container **120**. A securement device **140** projects upwardly through the second shroud aperture **133*b*** to secure the workpiece container **120** to the container support **130**.

FIG. **4** is a top isometric view of a portion of the container support **130** visible through a cut-away portion of the shroud **131**. In one aspect of this embodiment, the container support **130** includes a platform **136** carried by a support column **135**. The support column **135** moves upwardly and downwardly to position the workpiece container **120** (FIG. **2**) for loading and/or unloading. The platform **136** includes alignment pins **137** that align the platform **136** with the aperture **108** (FIG. **2**) of the cabinet **101** (FIG. **2**).

In one embodiment, the platform **136** also supports the securement device **140**. In one aspect of this embodiment, the securement device **140** includes grip members **150** (shown as a first grip member **150*a*** and a second grip member **150*b***) that engage the workpiece container **120** and secure it to the container support **130**. Further details of the structure and operation of an embodiment of the securement device **140** are described below with reference to FIGS. **5** and **6**.

FIG. **5** is an enlarged, top isometric, partially schematic view of an embodiment of the securement device **140** and a portion of the shroud **131**. A portion of the workpiece container **120** is also shown in FIG. **5**. In one aspect of this

embodiment, the floor **122** of the workpiece container **120** includes a floor aperture **124** extending from an external surface **126** of the floor **122** to an internal surface **125** (that can include shelf-like portions) positioned adjacent to the floor aperture **104**. The grip members **150***a*, **150***b* of the securement device **140** are configured to extend upwardly through the floor aperture **124**, engage the internal surface **125**, and draw the outer surface **126** downwardly against the support elements **134** (FIG. **4**).

In one embodiment, the first grip member **150***a* includes a first upwardly extending prong **153***a* and the second grip member **150***b* includes two upwardly extending prongs **153***b*. Each prong **153***a*, **153***b* has an outwardly extending contact portion **154** with a downwardly facing contact surface **155** configured to engage the inner surface **125** of the workpiece container **120**. The grip members **150***a* and **150***b* are pivotable toward and away from each other as indicated by arrows C. When the grip members **150***a*, **150***b* are pivoted toward each other, the first prong **153***a* of the first grip member **150***a* fits into a slot **152** between the second prongs **153***b* of the second grip member **150***b*. When the grip members **150***a*, **150***b* are pivoted toward each other and nested in this manner, they can move axially upwardly through the floor aperture **124** of the workpiece container **120**, with the contact portions **154** axially aligned with the floor aperture **124** and positioned above the level of the internal surface **125**. When the first and second grip members **150***a*, **150***b* are rotated outwardly away from each other (to the position shown in FIG. **5**) while positioned in the floor aperture **124**, the contact surfaces **155** are positioned directly above the internal surface **125** of the workpiece container **120**. The grip members **150***a*, **150***b* are accordingly positioned to grip the container **120** and draw the floor **122** of the container **120** downwardly against the support elements **134** (FIG. **4**), as described in greater detail below.

In one embodiment, the grip members **150***a*, **150***b* are pivotally coupled to a grip member support **151**. In a further aspect of this embodiment, the grip member support **151** is carried by a base **160** for linear axial motion, as indicated by arrow B. Accordingly, in yet a further aspect of this embodiment, the base **160** includes a linear actuator **163** coupled to the grip support **151** with an actuator shaft **162** to move the grip support member **151** axially upwardly and downwardly. The actuator **163** includes a pneumatic actuator in one embodiment, and in other embodiments, the actuator **163** includes other devices, such as hydraulic actuators, lead screws, or solenoids. In still a further aspect of these embodiments, the actuator shaft **162** is coupled to the grip members **150***a*, **150***b* with a linkage **164**. When the actuator shaft **162** moves downwardly, the grip members **150***a*, **150***b* moved apart, and when the actuator shaft **162** moves upwardly, the grip members **150***a*, **150***b* move together.

In one embodiment, the securement device **140** further includes spring pins **161** connected between the grip member support **151** and the base **160**. The spring pins **161** (or other biasing devices) tend to force the grip member support **151** upwardly away from the base **160**. As the actuator shaft **162** moves downwardly, the spring pins **161** initially keep the grip member support **151** at the same elevation. Accordingly, the initial downward motion of the actuator shaft **162** causes the grip members **150***a*, **150***b* to pivot outwardly away from each other, without lowering the grip member support **151**, until the grip members **150***a*, **150***b* contact corresponding upwardly facing stop surfaces **156** (one is visible in FIG. **5**) of the grip support member **151**. At this point, further downward motion of the actuator shaft **162** will not cause the grip members **150***a*, **150***b* to pivot outwardly any further. Instead, the grip members **150***a*, **150***b* bear downwardly against the upwardly facing stop surfaces **156**, causing the entire grip member support **151** to move downwardly against the upward force provided by the spring pins **161**. This motion causes the contact surfaces **155** of the grip members **150***a*, **150***b* to engage the upwardly facing interior surface **125** of the workpiece container **120**, and draw the workpiece container **120** downwardly against the support elements **134** (FIG. **4**).

In a further aspect of this embodiment, the securement device **140** includes one or more sensors **170** (two are shown in FIG. **5** as a first sensor **170***a* and a second sensor **170***b*) configured to detect the position of the grip member support **151**. In one aspect of this embodiment, each sensor **170** is a magnetic sensor that detects the position of a magnet located on the actuator shaft **162** or one of the spring pins **161**. In a particular embodiment, the first sensor **170***a* is triggered when the actuator shaft **162** is at its uppermost position, with the grip members **150***a*, **150***b* pivoted toward each other. For example, when the actuator shaft is in this position, a single magnet in the actuator shaft **162** is aligned with the first sensor **170***a*. The second sensor **170***b* detects the position of the magnet when the actuator shaft **162** has moved downwardly far enough to both engage the grip members **150***a*, **150***b* with the workpiece container **120**, and draw the workpiece container **120** downwardly against the support elements **134** (FIG. **4**). If neither the first sensor **170***a* nor the second sensor **170***b* are triggered, this indicates that either the actuator shaft **162** is stuck at an intermediate position, or the grip members **150***a*, **150***b* failed to engage the workpiece container **120**, allowing the actuator shaft **162** to move downwardly beyond the point at which the magnet in the actuator shaft **162** triggers the second sensor **170***b*. In other embodiments, the securement device **140** includes other sensor arrangements.

FIG. **6** is a bottom isometric view of the portion of the securement device **140** illustrating further details of the linkage **164** between the actuator shaft **162** and the grip members **150***a*, **150***b* (of which the second grip member **150***b* is visible). In one aspect of this embodiment, the linkage **164** includes a link support **163** extending outwardly from the actuator shaft **162**. A link **165** is pivotably coupled between the link support **163** and the second grip member **150***b* to pivot the second grip member **150***b* inwardly and outwardly (indicated by arrow C), as the actuator shaft **162** moves axially (indicated by arrow B).

The operation of a securement device **140** in accordance with an embodiment of the invention is described below with reference to FIG. **5**. To begin operation, the actuator shaft **162** is moved to its uppermost position, causing the grip members **150***a*, **150***b* to pivot toward each other so that the first prong **153***a* of the first grip member **150***a* fits into the slot **152** between the second prongs **153***b* of the second grip member **150***b*. The workpiece container **120** is then lowered onto the support surface **132** of the shroud **131** so that the grip members **150***a*, **150***b* project upwardly through the floor aperture **124**. The actuator **163** is then activated to move the actuator shaft **162** axially downwardly, causing the grip members **150***a*, **150***b* to pivot outwardly away from each other until the grip members **150***a*, **150***b* engage the stop surface **156** of the grip member support **151**. At this point, the contact surfaces **155** of the grip members **150***a*, **150***b* are positioned directly over the interior surface **125** of the workpiece container **120**, or in contact with the interior surface **125**.

The actuator shaft **162** continues to move downwardly, causing the grip member support **151** and the grip members

150*a*, **150***b* to move downwardly as a unit against the upward force provided by the spring pins **161**. Accordingly, the downwardly facing contact surfaces **155** of the grip members **150***a*, **150***b* contact the upwardly facing interior surface **125** of the workpiece container **120**, if they have not done so already. The actuator **162** continues to draw the grip member support **151** and the first and second grip members **150***a*, **150***b* downwardly to pull the floor **122** of the workpiece container **120** snugly against the support elements **134** (FIG. **4**). This operation securely engages the workpiece container **120** with the container support **130**. To release the container **120** from the container support **130**, the foregoing steps are reversed.

One feature of an embodiment of the securement device **140** described above with reference to FIGS. **2–6** is that the motion of the grip members **150** to align with the upwardly facing interior surface **125** of the workpiece container **120** is independent of, and in a different direction than, the motion required to engage the grip members **150** with the workpiece container **120** and draw the workpiece container **120** toward the support elements **134**. An advantage of this feature is that the grip members **150** are more likely to properly engage the workpiece container **120** because axial clearances in the floor aperture **124** the workpiece container **120** are very limited, and axial motion is not wasted simply to move the grip members **150** into position to engage the workpiece container **120**. This is unlike some existing devices (such as the one described above with reference to FIG. **1**) for which the action of positioning the engaging surfaces to contact the interior of the workpiece container also reduces the axial motion available for clamping the workpiece container to the container support.

A further advantage of embodiments of the securement device **140** is that unlike some existing devices, it can operate with workpiece containers having a wide range of manufacturing variations. For example, because securement devices **140** in accordance with embodiments of the invention have a greater range of available axial motion prior to clamping the workpiece container **120**, these securement devices can effectively operate with workpiece containers that are warped or otherwise out of tolerance.

From the foregoing, it will be appreciated that specific embodiments of the invention have been described herein for purposes of illustration, but that various modifications may be made without deviating from the spirit and scope of the invention. For example, other embodiments of the securement device have other arrangements that retain a substantial amount of available axial motion once in position to secure the workpiece container. Still further embodiments have other arrangements for which positioning the securement device for clamping entail motion in one direction, and clamping itself entails motion in another direction. Accordingly, the invention is not limited except as by the appended claims.

I claim:

1. An apparatus for handling microelectronic workpiece containers, comprising:

a container support having at least one support element positioned to carry a microelectronic workpiece container; and

a container securement device positioned at least proximate to the at least one support element, the container securement device having at least one contact surface, the at least one contact surface being movable relative to the at least one support element in a first direction between a first position and a second position, with the contact surface contacting or positioned to contact a surface of the microelectronic workpiece container when in the second position, the contact surface further being movable in a second direction from the second position to a third position with the contact surface clamping the microelectronic workpiece container against the at least one support element, wherein the second direction is different than the first direction.

2. The apparatus of claim **1** wherein the at least one contact surface is one of at least two contact surfaces, and wherein the container securement device includes first and second grip members, each having one of the contact surfaces, each grip member being pivotable to move one of the contact surfaces between the first position and the second position.

3. The apparatus of claim **1** wherein the surface of the microelectronic workpiece container bounds an aperture of the microelectronic workpiece container, and wherein the at least one contact surface is positioned to be received in the aperture when in the first position.

4. The apparatus of claim **1** wherein the at least one contact surface is pivotable in the first direction between the first position and the second position, and wherein the at least one contact surface is movable along a generally linear axis from the second position to the third position.

5. The apparatus of claim **1** wherein the securement device is configured to move the at least one contact surface in the first direction without moving the at least one contact surface in the second direction.

6. The apparatus of claim **1** wherein the securement device is configured to move the at least one contact surface in the second direction without moving the at least one contact surface in the first direction.

7. The apparatus of claim **1** wherein the securement device includes:

a base;

a grip member support;

a linear actuator coupled between the base and the grip member support;

at least one spring coupled between the base and the grip member support to force the grip member support away from the base;

first and second grip members pivotably coupled to the grip member support, each grip member having an outwardly extending contact portion, each contact portion being pivotable between the first position and the second position; and

a linkage coupled between the grip members and the linear actuator;

wherein axial motion of the linear actuator between a first actuator position and a second actuator position pivots the first and second grip members; and wherein

axial motion of the actuator between the second actuator position and a third actuator position moves the first and second grip members and the grip member support axially toward the base.

8. The apparatus of claim **1**, further comprising:

a plurality of processing stations positioned at least proximate to the container support; and

a transfer device positioned to move microelectronic workpieces between the containers and the processing stations.

9. The apparatus of claim **1** wherein the securement device includes:

a grip member support;

first and second grip members pivotably coupled to the grip member support, the first and second grip members each having a prong with an outwardly extending

contact portion, the contact portions of each of the first and second grip members being pivotable between the first position and the second position; and

a third grip member pivotably coupled to the grip member support, the third grip member having a prong with an outwardly extending contact portion, the contact portion of the third grip member being pivotable between the first position and the second position, at least a portion of the prong of the third grip member being received between the prongs of the first and second grip members when the contact portions are in the first positions.

10. The apparatus of claim **1**, further comprising a sensor positioned at least proximate to the securement device to detect motion of at least a portion of the securement device in at least one of the first and second directions.

11. The apparatus of claim **1** wherein the at least one contact surface is carried by a grip member pivotably coupled to a grip member support, and wherein the apparatus further comprises a linear actuator coupled to both the grip member and the grip member support, and wherein linear motion of the actuator over a first range pivots the at least one contact surface, and wherein linear motion of the actuator over a second range moves the contact surface along a generally linear path.

12. An apparatus for handling microelectronic workpiece containers, comprising:

container support means for carrying a microelectronic workpiece container; and

container securement means for releasably securing a microelectronic workpiece container to the container support means, the container securement means having at least one contact surface, the at least one contact surface being movable relative to the container support means in a first direction between a first position and a second position, with the contact surface contacting or positioned to contact a surface of the microelectronic workpiece container when in the second position, the contact surface further being movable in a second direction from the second position to a third position with the contact surface clamping the microelectronic workpiece container against the container support means, wherein the second direction is different than the first direction.

13. The apparatus of claim **12** wherein the container securement means includes first and second grip members, each grip member having a contact surface, and wherein the contact surfaces are pivotable between the first and second positions.

14. The apparatus of claim **12** wherein the container securement means includes first and second grip members, each grip member having a contact surface, and wherein the contact surfaces are movable along generally linear paths between the second and third positions.

15. A method for manufacturing an apparatus for handling microelectronic workpiece containers, comprising:

providing a container support having at least one support element positioned to carry a microelectronic workpiece container; and

positioning a container securement device at least proximate to the at least one support element, the container securement device having at least one contact surface, the at least one contact surface being movable relative to the at least one support element in a first direction between a first position and a second position, with the contact surface contacting or positioned to contact a surface of the microelectronic workpiece container when in the second position, the contact surface further being movable in a second direction from the second position to a third position with the contact surface clamping the microelectronic workpiece container against the at least one support element, wherein the second direction is different than the first direction.

16. The method of claim **15**, further comprising:

pivotably coupling a plurality of grip members to a grip member support, with each grip member having a contact surface that is pivotable between the first and second positions; and

coupling a linear actuator to the grip member support.

17. The method of claim **15**, further comprising pivotably coupling a plurality of grip members to a grip member support, with each grip member having a contact surface that is movable between the first and second positions.

18. The method of claim **15** wherein positioning a container securement device includes positioning a container securement device having the at least one contact surface being pivotable in the first direction between the first position and the second position, and wherein the at least one contact surface is movable along a generally linear axis from the second position to the third position.

19. The method of claim **15**, further comprising:

coupling a linear actuator between a base and a grip member support;

positioning at least one spring between the base and the grip member support to force the grip member support away from the base;

pivotably coupling first and second grip members to the grip member support, each grip member having an outwardly extending contact portion, each contact portion being pivotable between the first position and the second position; and

coupling a linkage between the grip members and the linear actuator;

wherein axial motion of the linear actuator between a first actuator position and a second actuator position pivots the first and second grip members; and wherein

axial motion of the actuator between the second actuator position and a third actuator position moves the first and second grip members and the grip member support axially toward the base.

20. The method of claim **15**, further comprising:

positioning a plurality of processing stations at least proximate to the container support; and

disposing a transfer device between at least one of the processing stations and the container support, the transfer device being configured to move microelectronic workpieces between the container support and the at least one processing station.

21. The method of claim **15**, further comprising:

pivotably coupling first and second grip members to a grip member support, the first and second grip members each having a prong with an outwardly extending contact portion, the contact portions of each of the first and second grip members being pivotable between the first position and the second position; and

pivotably coupling a third grip member to the grip member support, the third grip member having a prong with an outwardly extending contact portion, the contact portion of the third grip member being pivotable between the first position and the second position, at least a portion of the prong of the third grip member being received between the prongs of the first and second grip members when the contact portions are in the first positions.

22. The method of claim **15**, further comprising disposing a sensor at least proximate to the securement device to detect motion of at least a portion of the securement device in at least one of the first and second directions.

23. The method of claim **15**, wherein the at least one contact surface is carried by a grip member pivotably coupled to a grip member support, and wherein the method further comprises coupling a linear actuator to both the grip member and the grip member support, and wherein linear motion of the actuator over a first range pivots the at least one contact surface, and wherein linear motion of the actuator over a second range moves the contact surface along a generally linear path.

24. A method for securing a microelectronic workpiece container to a container support, comprising:

contacting the microelectronic workpiece container with a support element of the container support;

moving at least one contact surface of a securement device from a first position to a second position with the at least one contact surface contacting or positioned to contact a surface of the microelectronic workpiece container when in the second position; and

drawing the microelectronic workpiece container toward the support element with a second motion of the at least one contact surface in a second direction different than the first direction.

25. The method of claim **24** wherein moving the at least one contact surface in a first direction includes pivoting the at least one contact surface.

26. The method of claim **24** wherein moving the at least one contact surface in the second direction includes moving the at least one contact surface in a generally linear direction.

27. The method of claim **24** wherein the at least one contact surface is one of at least two contact surfaces, and wherein moving at least one contact surface includes pivoting a first contact surface in a first direction and pivoting a second contact surface in a second direction opposite the first direction.

28. The method of claim **24**, further comprising moving the at least one contact surface to the first position, with the at least one contact surface located within an aperture of the microelectronic workpiece container when in the first position.

29. The method of claim **24**, further comprising:

supporting a grip member support relative to a base;

forcing the grip member support away from the base with a spring;

pivoting first and second grip members relative to the grip member support between a first position and a second position to contact outwardly extending contact portions of each grip member with the microelectronic workpiece container, by moving an actuator coupled to the grip members between a first actuator position and a second actuator position; and

moving the actuator from the second actuator position to a third actuator position to move the first and second grip members and the grip member platform axially toward the base and clamp the microelectronic workpiece container.

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